

5 TITLE OF THE INVENTION

MAGNETIC BEARING ELEMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

10 The present invention is a U.S. national stage entry of international application number PCT/EP2004/007054 filed on June 30, 2004, which claims priority from German patent application number 103 33 733.4-51 filed on July 23, 2003, the contents of which are incorporated herein by reference and to which priority is claimed.

15 STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

THE NAMES OF THE PARTIES TO A JOINT RESEARCH AGREEMENT

20 Not Applicable

INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC

Not Applicable

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BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a magnetic bearing element having at least one annular permanent magnet that is surrounded by an annular binding band.

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Description of Related Art

Magnetic bearing elements of this kind for magnetic bearing arrangements are known. The document DE 38 08 331 C2 discloses a magnetic bearing that comprises two self-contained bearing components: a stabilization bearing and a center-of-gravity bearing.

35 This non-contact bearing system is implemented using annular permanent magnets and at least one further set of magnet rings that have an axial magnetization opposite to that of the first set. Such bearing arrangements are used predominantly in machines

5 that are operated at very high rotation speeds, for example turbomolecular pumps or flywheels.

To prevent the annular permanent magnets of the stabilization bearing from expanding, as a result of the large centrifugal forces occurring at high rotation speeds, to such an extent that the fits existing between the magnets become lost and the magnets burst (or shift in the axial direction and detach from the hub), concentric binding bands made of high-strength non-magnetic material having a high tensile strength, preferably a carbon-fiber material with a high tangential preload, are mounted from outside onto the annular permanent magnets during assembly of the bearing elements. These binding bands exert large, inwardly directed radial forces on the annular permanent magnets, counteracting the centrifugal forces that occur during operation.

A substantial disadvantage is the fact that much of the binding band preload is required simply to close the radial gaps between the concentric magnets, and between the inner magnets and the rotor hub. The extremely large centrifugal forces occurring at very high rotation speed can cause the permissible tensile stresses in the binding band, and the permissible compressive stress in the magnet material, to be exceeded. The consequence is that either the binding bands or the annular permanent magnets are destroyed.

#### BRIEF SUMMARY OF THE INVENTION

It is therefore the object of the invention to make available a magnetic bearing element that requires a lower preloading of the binding bands in order to close the gaps between the permanent magnets.

This object is achieved, according to the present invention, in that the respective permanent magnet is divided at at least one location and spaced apart there. The tangential supporting force occurring in an undivided permanent magnet is eliminated by this division. The divided permanent magnet can, as a result, be impinged upon by the binding band with a substantially lower pressure in order to overcome the gaps. The consequence is either that substantially larger centrifugal forces can act on the permanent magnets without causing the latter to expand and detach from the hub or to

5 shift axially, or that the preload can be made smaller, thus reducing the risk of  
destruction of the binding band or the magnet.

The necessary binding band preload can be made even smaller if the permanent  
magnet is divided and spaced apart at multiple locations. The division can also be  
10 embodied as a radially extending slit.

If the division locations are distributed regularly over the periphery of the permanent  
magnet, a homogeneous distribution of the force acting on the permanent magnets as  
a result of the binding band preload is achieved. Impermissible bending stresses in the  
15 magnet rings are also avoided.

In a manner known per se, the bearing element can comprise multiple permanent  
magnets arranged concentrically with one another, all of which are divided at at least  
one location and spaced apart there. Here as well, the tangential supporting force that  
20 occurs in permanent magnets embodied without a slit is eliminated. The binding band  
preload needed to produce an immovable compressive contact between the enveloping  
surfaces of the individual permanent magnets can, as a result, be made smaller.

When multiple permanent magnets arranged concentrically with one another are  
25 provided, the locations at which the permanent magnets are divided are  
advantageously offset from one another in the circumferential direction. The result is  
that bearing stability is further enhanced, the force acting on the magnets as a result of  
the preload is homogeneously distributed, and assembly is simplified.

30 Advantageous embodiments of the invention are disclosed in the dependent claims and  
in the description below of the drawings.

#### BRIEF DESCRIPTION OF THE DRAWING

Figure 1 illustrates a cross section of a magnetic bearing element according to an  
35 embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

The invention is illustrated in more detail, with reference to an exemplifying embodiment, in the Figure, which is a cross section through the magnetic bearing element according to the present invention. A hub 1 is surrounded by an annular magnet 2 that comprises radially extending slits 4 offset 90 degrees from one another. Adjoining this annular magnet 2, which is split into four segments, is a further annular magnet 3. The latter is likewise split into four segments by four radially extending slits 4 offset 90 degrees from one another. Slits 4 of annular magnet 3 are arranged with an offset of 45 degrees from slits 4 of annular magnet 2. A binding band 5 is mounted onto annular magnets 2, 3 and hub 1 with a preload, ensuring that annular magnets 2, 3, as well as annular magnet 2 and hub 1, are in contact against one another with an inwardly directed force.